

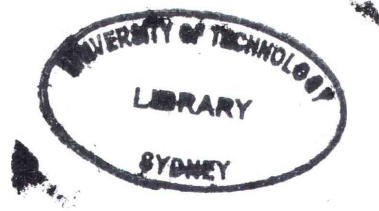
Towards Epistemic Autonomy in Adaptive Biomimetic Middleware for Cooperative Sensornets

Thesis by
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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

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Signature of Candidate

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Abstract

The importance of studying biomimetic models of software infrastructure for sensornet systems lies in the fact that they are not entirely formal models and thus have to cover a range of issues of epistemic autonomy as well as linguistic and mental adaptation. This adaptation considers the context of software ability to reflect upon the verifiability and validity of its actions and measurements. This research elucidates and explores epistemological consequences of embodying biological autonomic patterns in software architectural models. Autonomy in software systems is a complex issue that raises many fundamental inquiries. The proposal is to initially concentrate on transformations of biological paradigms into epistemological queries and then adapt suitable biomimetic mechanisms into the development of software structure and ethology. Such methodology has proven to be very successful in the design of many engineering systems. The approach leads to a better understanding of the ontology of biomimetic patterns in software as well as a confirmation of requirements validity and design verifiability of autonomous software systems. In a dynamic, cooperative but often hostile environment, a software system infrastructure requires autonomic abilities to execute its normal operations, detect faults and perform necessary recovery actions without the need for external intervention. We approach this problem from the point of view of cognitive and mimetic systems research. The simplest way to make an autonomous and adaptive sensornet system is to include a hierarchy of layers in its middleware, not only to monitor activities of its components but to learn and adapt new behavioural patterns of these components in a changing environment. There are situations, however, where the components will not be able to adapt, learn new behaviour and evolve by themselves. For instance, these may not have yet encountered the new situation while others already have. A solution to this problem is to distribute the new behaviour to neighbouring elements via direct and indirect stigmergy mechanisms so that collaborating components can mutually improve their individual and team performance. The main objective is to disallow distribution of multiple versions of the software components and rather allow each software component to acquire and share with others, new "skills". The components have to compare/verify these new behavioural patterns against their own set of beliefs, desires and intentions. In this thesis we intend to present simulations to test the learning capability of biomimetic algorithms, build a proof-of-concept middleware solution and demonstrate that such systems can not only adapt and evolve but they are robust and highly interoperable (co-operative). The thesis also assesses the suitability of various biomimetic design patterns and algorithms for building autonomic software infrastructure systems for cooperative networked agents.

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